NASA DEVELOP: SUMMER 2012

Assessing Impacts of Mountain Pine Beetle on Forest Stand Structure: Mapping Forest Characteristics Using Spatial Analyses and NASA Earth Observing Systems to Support Management Response Strategies and Restoration Efforts in Fraser Experimental Forest

By

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Ext. Scene (Opening animation/PPT image series).

NASA Earth Science animation plays, then transitions to DEVELOP summer 2012 slide, which fades into the Colorado Eco-Forecasting title slide. Music begins playing at the start of the second slide (*opening scene music written, composed and recorded by FCSC DEVELOP center lead Matt Luizza on Garage Band program for Mac. Royalty free clip).

Ext. Scene.

Series of open public domain imagery and imagery taken by FCSC team members of mountain pine beetle and its resulting damage (date and location of picture noted on each image with image sources noted at the end of the video). Transitions to 13.73 second video time series of mountain pine beetle spread across the western United States from 1994-2010 (opening scene music still playing in background).

Matt (voice over)

Although endemic and holding an important role in forest ecosystem processes, the recent outbreak of mountain pine beetle shows unprecedented spatial extent across the western United States. From 1994 to 2010 the beetle's spread was estimated to impact some 6.1 million acres of pine forest. 4 million of which is located in Colorado and southern Wyoming alone. Aerial detection surveys have proven effective at measuring the rate of beetle spread but can't accurately determine how much of the forest overstory is affected by beetle mortality.

Ext. Scene.

Google Earth zoom-in to the Fort Collins Science Center. Transitions to B-roll footage of NASA DEVELOP team working in their office which then fades into the power point slide with names and pictures of the team members, science advisors and agency partner mentors, followed by the power point slide of the study site followed by the community concerns power point slide. (*background music written, composed and recorded by FCSC DEVELOP team member Steve Chignell on Garage Band program for Mac. Royalty free clip).

Steve (voice over)

Housed at the USGS Fort Collins Science Center (the newest NASA DEVELOP location) the Colorado Ecological Forecasting team consulted with science advisors and Forest Service partners to create a more detailed forest cover classification model of Fraser Experimental Forest. Located in Grand County, Colorado, just 70 miles west of Denver, the study site is one of 80 experimental forests and ranges run by the Forest Service. Creating an accurate model of forest cover across the landscape will assist in addressing the diverse and often overlapping concerns of community members linked to the mountain pine beetle.

Ext. Scene.

Objectives Power Point Slide revealing the project methods flow chart and introducing each component of the methodology in a step-wise manner.

Steve (voice over)

This project utilized NASA Earth Observing Systems in concert with field data collected in 2008 by the USDA Forest Service. These data were prepared and run through a Gaussian Boosted Regression Tree model, with the raw output being categorized tree distributions by species. This output was subsequently refined and reclassified to create a preliminary forest cover map that was run through a series of validations using field data collected in June and July by the DEVELOP team.

Ext. Scene.

Animation of Landsat5 satellite orbiting Earth followed by a transition through Methods Power Point slides.

Steve (voice over)

The first step in our methodology was to acquire NASA Landsat 5 imagery from July 1997 for the preliminary model. This date was chosen because it precedes the discoloration observed with beetle-kill trees. Both NDVI and Tasseled Cap transformations were derived using ENVI software--not only to highlight green areas but also to act as predictor variables in the different model runs. We also acquired a 30 meter SRTM digital elevation model which we used to derive both slope and aspect layers of the forest. All these layers were prepared for use in the boosted regression tree model. Our next step was to couple the remotely sensed data with a tree

database of 74 quarter-acre circular plots calibrated by the Forest Service in 2008. Each tree in each plot was tagged, measured and catalogued according to its species. We then went into the field validating 52 additional plots with 7.2 meter radius. These plots were stratified across the study site and served as a way to ground truth our model. After these data sets were run through the model, the raw raster outputs of each species were classified by percent abundance. Because of their similar canopies Engelmann spruce and subalpine fir were combined. Aspen was dropped from the final map due to a lack of field sampled data.

Ext. Scene.

Transition through Results Power Point slides showing both the preliminary model map output and subsequent re-calibrated baseline model map output.

Matt (voice over)

Our first model produced a map comprised of four species abundance thresholds ranging from 15 percent and below abundance to 55 percent and above abundance. The map was validated with over 100 observation points run through an error matrix which summarized the relationship between the model and the field validation data to produce an initial accuracy of 73%. A second model was run with additional Landsat 5 imagery from 1994 through 1997 with adjusted abundance thresholds including an increased upper bound of 90 percent and above abundance and removal of all non-conifer forest observations from the validation process which noticeably padded our first model's accuracy. This reduced the second model's accuracy to 57 percent, but coupled with low adjusted R-squared values of both models (which could only explain 20 percent of the variance) reveals the need for additional model predictors including multi-season Landsat 5 and 7 imagery, soils data and additional validation plots.

Ext. Scene.

Transition through Conclusion Power Point slide.

Matt (voice over)

Our initial findings demonstrate the utility of boosted regression tree modeling in concert with Landsat 5 imagery to create an accurate forest cover classification model with limited predictor data sets. A final re-calibrated model displaying pre and post-beetle infestation maps will act as an important decision support tool for resource managers, community members and researchers addressing bark beetle outbreaks in the region. Future DEVELOP terms will produce this final model to use in concert with digital hemispherical photography to estimate beetle mortality and changes in canopy coverage and forest stand regeneration in Fraser Experimental Forest.

Ext. Scene.

Acknowledgements slide scrolls through a list of the people and organizations the NASA DEVELOP Colorado Ecological Forecasting team would like to thank for their contributions, in addition to noting music and photo credits.

Matt (voice over)

From all of us at the Fort Collins Science Center team, we thank everyone involved in this project for their contributions, the NASA DEVELOP program for this opportunity and thank you all for watching our video.